PNNL finds exposure to estrogen cuts fish fertility

Staci Maloof, *Pacific Northwest National Laboratory*

While several studies have focused on how estrogen from contraceptives may alter sex organs of juvenile fish, few studies have analyzed how exposure to estrogen affects adult fish as they make their way through rivers, lakes and streams to spawn. Now, a study by scientists at the Department of Energy's Pacific Northwest National Laboratory suggests that, when adult male fish are exposed to low concentrations of a synthetic estrogen, even for a short term, their fertility can drop by as much as half.

The study, conducted by PNNL and the University of Idaho, appears in the June issue of *Environmental Toxicology and Chemistry.*

Previous research reported that high concentrations of estrogen could change sex organs, causing juvenile male fish to develop female organs. Estrogen is an active ingredient in most oral contraceptives and often finds its way into surface waters through sewer systems. The PNNL study looked at the impact of a synthetic estrogen called ethynylestradiol, which is the chemical in oral contraceptives.

Irvin Schultz, the PNNL toxicologist who led the study, said the research shows that the impacts are not limited to juvenile fish. "We can see that adult fish aren't immune to the effects of estrogen in waterways," Schultz said. "Even short-term exposure to low levels of synthetic estrogen can impact their fertility. Our results indicate that the fertility of a healthy male trout that has developed normally still can be affected if that exposure takes place during a critical sexual maturation stage before spawning."

In a controlled laboratory experiment, PNNL scientists at the lab's Marine Sciences Laboratory in Sequim, Wash., exposed adult male rainbow trout for 62 days to three different concentrations of ethynylestradiol — 10, 100 and 1,000 nanograms per liter of water. The sperm of exposed fish were harvested, and then used in a controlled in-vitro fertilization process with eggs from a healthy female rainbow trout. After 28 days, a measurable decrease in fertilization was observed in the treated trout compared with a control group.

In some experiments, a 50 percent decrease in fertilization capability was noted in semen collected from the trout exposed to the lowest of the three concentrations. For example, in an experiment using 50,000 sperm for one egg, the exposed fish had 22 percent fertilization compared with 45 percent fertilization of the control fish.

That impact is important, say researchers, because 10 nanograms per liter is a level found in some surface water samples.

Schultz and his colleagues, including co-author Jim Nagler of the University of Idaho, studied the possible mechanisms for reduced fertility, specifically sperm motility and decreased hormone levels. While they were able to rule out sperm motility as the mechanism, their research revealed increased — not decreased — hormone levels in the blood plasma of fish exposed to 10 nanograms per liter of ethynylestradiol. But hormone levels did decrease in fish exposed to the larger concentration of 100 nanograms.

"While other research has shown the visible change that can take place when young male fish are exposed to high levels of estrogen, we're suggesting that low and short-term exposure can have just as significant — but not physically observable — effects," Schultz said. ■